AFRL-SR-BL-TR-01-

0243

REPORT DOCUMENTATION PAGE

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
20-03-2001	Final	06-01-00 to 11-30-00

4. TITLE AND SUBTITLE

Activity Monitoring Equipment

5a. CONTRACT NUMBER

5b. GRANT NUMBER
F49620-00-1-0322

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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8. PERFORMING ORGANIZATION REPORT NUMBER

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13. SUPPLEMENTARY NOTES

14. ABSTRACT To evaluate the impact of sleep and waking alertness on the operational success of Air Force personnel, a system of individual monitoring is required. Monitoring is essential for evaluating the operational readiness of critical personnel, predicting individual differences in performance during sustained operations and jet-lag/shift work operations, and for use as a selection tool to identify individuals who may be better suited for particular missions. The current research was designed to implement the use of an unobtrusive ambulatory monitor (Actiwatch-L, Mini-Mitter Corporation, Bend, Oregon) to record ambient light level and wrist actigraphy of all subjects prior to the sleep deprivation jet-lag protocol; and to develop and conduct near-real-time analysis of these sleep and light exposure data. Data collected from these individuals will be analyzed using our most recent mathematical model that predicts waking alertness and neurobehavioral performance as well as circadian phase from activity (sleep-wake) and light history.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Willard Larkin/AFOSR
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PROGRESS REPORT

Submitted on 28 February, 2001
to
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by
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ACTIVITY MONITORING EQUIPMENT

Grant Number: F49620-00-1-0322

Performance Period: 01 Jun 00 – 30 Nov 00

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2. Objectives:

Sleep is a basic biological need that is vital to the operational success of Air Force personnel. Laboratory-based studies indicate that chronically - inadequate sleep and sustained wakefulness, such as have been reported to occur in aircrew members, lead to profound decrements in human performance, including slowing of reaction time, impairment of short-term memory, degraded neurobehavioral performance, and lapses of attention, each of which could jeopardize mission success.

Given the impact of sleep and waking alertness on the operational success of Air Force personnel, a system of individual monitoring may be an essential component for: a) evaluating the operational readiness of critical personnel, b) predicting individual differences in performance during sustained operations and jet-lag/shift work operations, c) use as a selection tool to identify individuals who may be better suited for particular missions.

The timing of both the light-dark cycle, which is the most potent circadian synchronizer in the environment, and the sleep-wake cycle of personnel prior to deployment, can be monitored continuously and non-invasively on a routine operational basis using technology that has been developed over the past decade. The routine monitoring of wrist actigraphy and light exposure in personnel prior to critical missions would be a significant first step in assessing the problems associated with sleep-related neurobehavioral performance deficits in a meaningful way.

The Acitwatch-L light/activity monitors allow us to record wake-sleep activity patterns and light-exposure history in all individuals prior to admission into the laboratory for our AFOSR funded study and during the entire 31 days that they are in the laboratory our goal is to then use these subjects' previous light exposure and sleep-wake history to predict individual differences in a adjustment to shift work and SUSOPS.

The Acitwatch-L recorder (Mini-Mitter, Inc., Bend, OR) is a small wrist worn device (17 grams) that measures activity and ambient light exposure. The Acitwatch-L is made of titanium and a reinforced plastic case; is waterproof; powered by a 3V, 150 mAmp-hr Lithium Manganese battery that has a lifetime of 180 days; data is preserved if the battery expires. Once initialized, the Acitwatch-L can record data for 22 days (2 min sampling rate) and it can be programmed to become active at a designated time. Data is downloaded from the Acitwatch-L via the Acitwatch Reader. This interface reader is attached to a computer and the Acitwatch-L transfers data to the reader telemetrically (no cable connection required).

Data files in ASCII format allow raw data to be imported into spreadsheet and database software. Actiware-Sleep scoring software calculates sleep summary data such as estimates of sleep efficiency, sleep fragmentation, total sleep time and the number of wake and sleep bouts. The software also analyzes light exposure data in lux (e.g. maximum, average exposure).

The Acitwatch-L recorder senses motion (an accelerometer). The degree and speed of each motion produces an electrical current that varies in magnitude and is stored as an activity count.

The software allows for choosing bin length for both collection and analysis of data. The scoring software allows the sensitivity of the watch to be modified for analysis.

Specifically, we proposed to:

1) Implement the use of an unobtrusive ambulatory monitor (Actiwatch-L, Mini-Mitter Corporation, Bend, Oregon) to record ambient light level and wrist actigraphy of all subjects prior to the sleep deprivation jet-lag protocol.

2) Develop and conduct near-real-time analysis of these sleep and light exposure data collected from these individuals using our most recent mathematical model which predicts waking alertness and neurobehavioral performance as well as circadian phase from activity (sleep-wake) and light history.

3. Status of Effort:

We purchased 25 Actiwatch-L actigraphy and light exposure-recording units. They were delivered on 08/30/00 and were subsequently inspected and tested before use in our studies.

The equipment purchased accelerated our currently funded AFOSR research grant F49620-95-1-0388 entitled "Homeostatic and Circadian Regulation of Wakefulness During Jet Lag and Sleep Deprivation: Effect of Wake-Promoting Measures", by significantly upgrading our older equipment, and therefore allowing us to better achieve the objectives outlined within the scope of that project.

4. Accomplishments/New Findings:

The new Actiwatch-L recorders worked very effectively in measuring sleep-wake activity and light exposure patterns in research subjects. Work is ongoing to develop and optimize a transformation function so that data collected by the wrist worn Actiwatch-L can be directly input into the mathematical model of the effects of light exposure of varying duration and intensity on the human circadian system and performance. We have currently determined that the Actiwtch-L readings can be transformed to the equivalent of IL-1400 meter readings by a simple transformation function. Wrist position is a significant factor in the Actiwatch-L light readings that we are investigating further.

5. Personnel Report:

There are no budgetary costs for personnel.

6. Publications:

None

7. Interactions/Transitions:

A. Participation/presentations:

None

B. Consultative and advisory functions:

None

C. Transitions:

None

8. New discoveries, inventions, or patent disclosures:

None

9. Honors/Awards:

None